of colour is a secondary effect; in presence of radium the diamond is extremely phosphorescent, and it continues to shine during the whole time of the experiment. This constant state of vibration in which the diamond was kept for many weeks may have caused an internal change revealing itself in a change of colour. Indeed, it is not difficult to suppose that a chemical as well as a physical action may result. If the yellow colour is due to iron in the ferric state a reduction to the ferrous state would quite account for the change of colour to a pale blue-green.

This alteration of colour may be of commercial importance. If "off colour" stones can be lightened their value will increase, while if the prolonged action of radium is to communicate to them a decided colour they would be worth much more as "fancy" stones.

[*Added June* 16.—After the ten days' heating in the above acid mixture the two diamonds were put together in a glass tube and carried about for twenty-five days, sometimes loose and sometimes in the tube. They then were laid near together on a sensitive film in total darkness for twenty-four hours. On developing, diamond B had impressed a strong image on the film, but only a very faint mark could be seen where the other diamond had been. Probably this slight action was due to a little radio-activity induced in A during its twenty-five days' proximity to B.

The experiment was then repeated for confirmation, allowing the diamonds to remain on the sensitive surface for only five hours. On development, a good image of diamond B was seen, but not so black as in the former case.

The fact that diamond B was strongly radio-active after it had been away from radium for thirty-five days, for ten of which it was being heated in a mixture powerful enough to dissolve off its outer skin of graphite, seems to me proof that radio-activity is by no means a simple phenomenon. It not merely consists in the adhesion of electrons or emanations, given off by radium, to the surface of an adjacent body, but the property is one involving deep-seated layers below the surface, and like the alteration of tint is probably closely connected with the intense phosphorescence the stone had been experiencing during its seventy-eight days' burial in radium bromide.]

THE MARKINGS AND ROTATION PERIOD OF MERCURY.

MUCH new light was thrown upon the rotation period of Saturn during the year 1903, and it seems highly probable that the next planet to afford us information as to the same feature will be the planet Mercury. Spots of very definite and distinct character are certainly visible on the surface of this fugitive little orb, which offers a more promising field for new discoveries than Venus, though it is considerably smaller, at a much greater distance from us, and more unfavourably placed for observation. The markings sometimes perceptible on Mercury appear to be of sufficient prominence to be followed, and if really capable observers are forthcoming, at the opportune period, to study them, it will be possible to ascertain once and for all whether this circumsolar planet turns on its axis once in about 24 hours or 88 days, and an important advance in our knowledge will have been made.

Spots have been discerned on Mercury since the time of Schroeter about a century ago. Among those who have obtained observations of them are the following:—

Schroeter	1800	Denning	1882
Harding	1801	Schiaparelli ...	1882–3
Bessel	1801	Brenner	1896
Prince	1867	Lowell	1896
Birmingham ...	1870	Barnard	1900
Vogel	1871	McHarg	1904

In 1800 Schroeter announced that the rotation period was about 24h. 4m. from blunted appearances of the southern horn, but doubted if the value could be determined to within a few minutes. In 1801 Harding perceived a dusky spot in the southern hemisphere, and derived the period as 24h. 5m. 30s. Further observations, however, obtained by himself and Bessel caused him to reduce this period to 24h. 0m. 50s. Bessel found 24h. 0m. 53s. from several of Schroeter's observations extending over fourteen months. In 1882 Denning, at Bristol, thought a period of about 25 hours would satisfy the observations, but Schiaparelli, in the pure Italian sky, arrived at very different results, and concluded that the planet rotated in 88 days, or in the same period as he revolved round the sun. Quite recently McHarg found the time 24h. 8m. from his own observations of a dark spot in April, 1904. He also deduced a period of 24h. 5m. 48s. from a blunting of the southern horn seen by Schroeter in 1800 March, and by Denning in 1882 November.

ON THE DIMENSIONS OF DEEP-SEA WAVES, AND THEIR RELATION TO METEOROLOGICAL AND GEOGRAPHICAL CONDITIONS.[1]

THE following table has been compiled from the original sources after re-calculating the true velocities corresponding to the "Beaufort numbers" in accordance with the alteration of reduction factor adopted by meteorologists since the date of the observations:—

Table showing the Relation between the True Velocity of the Wind in Statute and in Geographical Miles per Hour and the Height of the Wave in Feet, as deduced from Observations by numerous French Observers extending over many years and taking in all the Oceans.

No. of wind on Beaufort's scale of 0–12	Velocity of wind, stat. miles per hour	Velocity of wind, geographical miles per hour	Height of wave in feet	Authority	Velocity of wind in stat. miles per hour divided by height of wave in feet	Velocity of wind in geographical miles per hour. divided by height of wave in feet Feet
0·00	2·0	1·7	1·97	Desbois	1·01	0·86
1·50	5·5	4·8	3·28	,,	1·68	1·46
3·00	10·0	8·7	4·92	,,	2·03	1·77
3·60	12·4	10·8	6·17	Antoine	2·01	1·75
4·36	15·8	13·7	6·56	Paris	2·41	2·09
4·50	16·5	14·3	7·55	Desbois	2·19	1·89
4·80	18·0	15·6	9·12	Antoine	1·97	1·71
5·45	21·7	18·9	13·45	Paris ("Grosse Houle")	1·61	1·41
6·00	25·0	21·7	10·83	Desbois	2·31	2·01
6·00	25·0	21·7	13·12	Antoine	1·91	1·65
6·55	28·3	24·6	11·65	Paris	2·43	2·11
7·20	32·2	28·0	17·0	Antoine	1·89	1·65
7·50	34·0	29·5	15·42	Desbois	2·20	1·91
8·18	38·3	33·3	16·57	Paris	2·31	2·01
8·40	39·8	34·6	16·73	Antoine	2·38	2·07
9·00	44·0	38·2	20·67	Desbois	2·13	1·85
9·60	49·2	42·7	21·98	Antoine	2·24	1·94
9·82	52·2	45·3	25·43	Paris	2·05	1·78
10·50	58·2	50·5	28·54	Desbois	2·04	1·77
10·8	61·8	53·7	27·89	Antoine	2·22	1·93
				Average	2·03	1·78

This table gives the average of many hundreds of days' observations conducted at various times during a period of about forty years by independent observers, all French seamen of the navy or merchant service, carried out in almost all parts of the oceans ordinarily visited by ships, and from many different vessels (none, however, of the great size of our modern liners, and therefore better for such observations), and shows the average height of the wave, in open sea with sufficient depth of water, to be in simple arithmetical proportion to the velocity of the wind, *the height of the wave in feet being in round numbers one-half of the velocity of the wind in statute miles per hour.*

This result does not express a dynamical law; it is simply

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[1] Extracted from a paper by Dr. Vaughan Cornish in the *Geographical Journal* for May, 1904.

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the result of averages, but if confirmed by further observation it will have considerable interest for geographers, meteorologists, and for those who have to do with the sea.

We may take 20-feet average waves and 30-feet occasional waves as the limit in very severe gales in the "seas," and 30-feet average and 45-feet "ordinary maximum" waves as the limit of wave-height for the oceans. Although strong winds will push short waves to a considerable steepness, yet they are not able to attain quite so great a height as somewhat longer waves, because, moving more slowly, their tops give way under the great difference of wind-pressure upon their two sides. Thus the development of the larger waves primarily depends upon the opportunity to attain greater *length*. It is in this respect that our consideration of the size of the cyclone becomes so important for deep-sea waves, especially for explaining the co-existence of the steep storm waves with the swell.

The slighter development of the longer waves is undoubtedly influenced by the dual circumstance that the length of fetch of wind of the required velocity diminishes (the stronger winds only blowing for a short *time* at a fixed station, or for a short *space* in the travelling cyclone), whilst the requisite fetch is greater, for it must be a *large multiple of the wave-length*. Thus the limit of length of the steep waves is rapidly approached from the concurrence of the two causes operating, so to speak, from opposite directions.

Taking T. Stevenson's table ("Enc. Brit.," ninth edition, art. Harbours) of the relation of height of waves to length of fetch, and multiplying the heights by twenty (as a first approximation) to obtain the length, we see that a considerable wave does not become the dominant form except with a fetch *approaching* 2000 *times its wave-length.*

Extending these results to 30-feet (average) waves 600 feet long, *i.e.* fully grown ocean storm waves, we see that 30-feet×20×2000=227 statute miles, or 197 geographical miles.

A 9-hours' blow, with wind 64 miles per hour, was recorded in the gale of December 22, 1894. With the average velocity of advance of deep depressions from W.S.W. on our coast, viz. 24·8 (say 25) knots, this would give a length of fetch of 225 geographical miles. The height of wave corresponding to this length of fetch in severe gales, as calculated by stretching Stevenson's formula, is 22·5 feet. If the cyclone had the exceptional speed of 60 knots, the length of fetch of the 64-mile-an-hour wind would be 450 miles, which with Stevenson's formula gives a height of 31·8 feet. A thirty-foot wave from the same formula requires a length of fetch of 400 miles. Both this length of fetch and this height of wave are probably more normal in the southern ocean than in the North Atlantic; the 22·5-foot wave and the 225-mile length of fetch would be more the scale of things there.

If we take the case of a very long swell of 2000-feet wave-length (unusual, but within the records), which is one-third of a geographical mile, then 2000 times this wave-length is 666 miles. The speed of such a swell is 69 knots, and wind of greater velocity than this would only be blowing in a comparatively short strip of even a great cyclone. They would, therefore, not be developed into the dominant wave form, however strong the wind might be there. The reason for this is most easily understood if we imagine a short series of such waves to exist with the steepness of ordinary storm waves. If 76-miles-per-hour wind last one hour at a fixed station (which occasionally happens on our coasts), and the rate of advance of the storm be 25 miles per hour, then the stretch of water at any time exposed to the above force of wind is 25 miles, which would comprise only 75 such waves.

Suppose these, or any of them, to have attained considerable steepness, it is evident that the arrangement would be unstable, for there would be so great a difference of steepness between neighbouring waves that the group would speedily extend itself, multiplying the number of its waves and flattening them out, until the gradation from one wave to the next is almost indefinitely small.

Although the length of fetch in cyclones is inadequate to the development of the longer observed swells to great steepness, the length of run of the cyclones on the oceans is frequently such as afford much more than the time required for the full development of ordinary storm waves. Thus a cyclone travelling a little less than 25 knots, the average speed of deep depressions approaching our shores from the Atlantic, travels with the group velocity of a swell of 16-seconds' period (or 1311-feet wave-length), the speed of such waves being 48·56 knots, and their group velocity being, therefore, 24·28 knots. Such a storm, if brewed in mid-Atlantic, and advancing on our shores from W.S.W., would continually reinforce this swell during three days, a space of time equal to 16,200 times the period of the wave.

It is an interesting coincidence that the average velocity of deep depressions approaching our coasts from points between W.S.W. and W.N.W. (25 knots) is about half that wind velocity called "a severe gale" by Brodie (viz. Beaufort's 10, 53 statute miles per hour, 46 knots). Of the sixty recorded cases of more rapidly advancing storms, twenty-five had a speed of 31 to 34 knots, which is again about half the maximum observed wind velocity (except in gusts).

Thus we have a dual correspondence of velocities, the individual wave of the longest swells moving with nearly the velocity of the strongest winds, and the group of swells advancing with nearly the velocity of the great storms.

When, as often happens (in the North Atlantic), a long swell precedes and predicts the arrival of a storm, the rate of advance of the latter is less than half the speed of this swell in deep water.

A slowly moving storm with violent winds will raise a short steep sea with comparatively little swell in it.

The rate at which a wave flattens out when the wind ceases is inversely as the square of its length. Consequently, in oceans large compared with the areas of cyclonic storms, the surface is found to be heaving with a long swell during the intervals between storms (whence the grand surf which rolls in upon oceanic islands). New storms will not, as a rule, catch up a group of such swells, but cyclones brewed upon the ocean find such a swell already running, and, travelling with it, soon increase its steepness. This is particularly true of the circumterrestrial waters of the southern hemisphere, where a long swell from the west is always running.

It is probable (and experience at sea supports the opinion) that in moderately high latitudes of the southern hemisphere, say 40° to 60° S., the cyclones are on a larger scale than in the corresponding latitudes of the northern hemisphere, where atmospheric movements are more broken up by the alternation of land and water. The bigger waves of the southern ocean I attribute only indirectly to the greater expanse of water. The expanse of water in the northern Pacific and northern Atlantic would amply suffice for the development of larger waves than actually occur there were the storms which traverse them framed on a larger scale.

GEOLOGY IN NORWAY.

THE last "Year-book of the Norwegian Geological Survey" (1903) contains five papers bearing on different subjects concerning the geology and topography of Norway.

In the first paper, the aged mining engineer Mr. Friis deals with Jurassic coal beds on the Andö, an island in northern Norway. The sandstones and slates of the Brown Jura contain good cannel coal of 1 metre thickness, but cover rather a small area.

In the second paper, Dr. H. Reusch, the chief of the Survey, describes a journey through the interior of the most northern province of Norway, a desolate and almost uninhabited country, to visit the gold fields near the Russian border. Gold occurs in a Glacial deposit, "aas" or esker, but only in small quantities. Dr. Reusch describes the country upon the whole as a peneplain 300 to 500 metres above the sea. Glacial deposits widely cover the land, and solid rock, mostly archæan and sandstones of supposed Devonian age, is only seldom seen.

In two papers, Mr. Kaldhol and Mr. Rekstad deal with the succession on "Hardangervidda," the wide plateau on an average 1300 metres above the sea, with peaks ranging

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